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ACTIVATING THREE LANGUAGES SIMULTANEOUSLY IN MENTAL LEXICON: AN INVESTIGATION OF NEPALI – ENGLISH – SANSKRITPARALLEL LANGUAGE ACTIVATION

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ABSTRACT

This is the first study investigating the nature of trilingual parallel language activation in Nepal-English-Sanskrit triad. Twenty-four participants have been divided into groups of 8 based on the dominance of the three language use to understand the nature of activation in three groups. Stimuli consisted of audio-visual bimodal in nature. An emerging novel technology Mouse Tracker that can study continuous unfolding of cognitive processing has been used to design the experiment and collect the software generated data. The data has been analyzed using SPSS and visualized using R. Results which showed when three languages are activated simultaneously, the phonological similarity plays a facilitating role. The results are explained in line with BLINCS (Bilingual Language Interaction Network for Comprehension of Speech) model.

Keywords: Trilingualism - Nepali-English-Sanskrit - linguistic and cognitive processing - mouse tracking - spoken language processing

INTRODUCTION

Bilingualism or multilingualism is drawing more and more attention of the large population of the world who speak more than one language. So, it is being used both as a subject of study as well as a tool to investigate brain, cognition and language (Kroll, Bobb & Hashino 2014) in recent days. Three major discoveries in this field have established that (i) both languages or all the languages in the mental lexicon of the speaker are always active showing language co-activation; (ii) bilingual or multilingual practice affects both L1 and L2 leading to language reconfiguration; (iii) bilingualism/multilingualism reconfigures the entire cognitive network (Kroll & Bialystok 2013), in the areas of brain areas that control cognitive functioning which also overlap with the areas that control language (Garbin et al, 2010; Abutalebi & Green 2007). The health benefits of bilingualism have been found to produce cognitive reserve which protect bilinguals from the symptoms of neuro degenerative diseases like dementia or Alzheimer's (Bialystok, Craik & Freedman 2007, Alladi *et al.* 2013)

During auditory recognition when the bilinguals confront a large cohort of similar-sounding words, they may recruit domain-general cognitive control mechanisms routinely to meet their expected linguistic requirements. In the everyday environments, cross linguistic activation between both the languages and resolving the conflict to select the task relevant language needed for the current goal permeate the receptive language processing among bilinguals (Blumenfeld & Marian 2013). High proficient bilinguals outperform less proficient bilinguals (or monolinguals) in a host of cognitive tasks like good language switchers are good task switchers (Prior & Gollan 2011), better at conflict monitoring and resolution (Singh & Mishra 2013).

As of now, Cognitive Science is not taught yet in Nepali higher education whereas psycholinguistics is taught as part of Linguistics and Applied Linguistics in some departments in Tribhuvan University. Even the components of psycholinguistics that is taught is only theoretical and there is no infrastructure yet for conducting empirical experimental research in psycholinguistics and cognitive science. A small move in this direction has started at the Central Department of Linguistics where this researcher has to establish Cognitive Science and Psycholinguistics Lab with the aim of training the students with the concepts, methodology, tools and techniques of conducting research in this emerging scientific area to initiate and institutionalize this field of academic potential (Pathak 2022).

Some substantial steps in the direction of initiating and institutionalizing Psycholinguistics and Cognitive Science have already been taken in Tribhuvan University, the leading university in Nepal. Prof. Jubin Abutalebi, Director, Center for Neurolinguistics and Psycholinguistics, at Universita Vita-Salute San Raffaele, Italy who is a leading scientist and researcher in the area of bilingualism and multilingualism and how do the multiple language representation and processing shape and impact our human brain visited Nepal in October 2016 and delivered his talk in the Central Department of Linguistics and then just established Language Commission. He gave a talk on monolingual, bilingual and multilingual brains and gave evidences from his research and publications how a bilingual/ multilingual brain is cognitively more efficient in attentional control and language control. He also spoke of bi/multilingual brains being more efficient in literacy processing and protecting against neurodegenerative disorders like dementia (Abutalebi *et al.* 2015, Perani & Abutalebi 2015). Pathak (2001) published his research on transfer errors in Nepali learners of English showing the linguistic structure of Nepali L1 being interposed in English L2. Pathak (2004, 2005, 2007) conducted the first longitudinal case study on Nepali child language acquisition which covers the age period of 6 months to four and half years. Pathak and Dahal (2010) for the first time explored the situation of dyslexia in a Nepali sample of school students. Pathak and Pathak 2018 presented a paper on bilingual Stroop effect on high and low proficient Nepali -English bilinguals in the 39th Annual Conference of Linguistic Society of Nepal held during November 26 - 27, 2018 which was subsequently published (Pathak & Pathak 2022). This was the first study from Cognitive Science and Psycholinguistics Lab in which an intern had made an academic conference presentation after learning the method of doing such research in this lab. A presentation was given by Pathak (2019) on how bilinguals activate both their languages simultaneously and how this modulates cognitive control on the theme of parallel language activation and cognitive control in bilinguals in the 2nd Annual Conference of Applied Linguistics and ELT during 9- 11 February, 2019 which was organized by the Department of English Education, Tribhuvan University. In order to create awareness on the possibility of Cognitive Science in Nepal, this researcher delivered an invited talk on March 22, 2019 which was organized by Nepal Norway Alumni Association at the Hydro Lab Seminar Hall in Lalitpur in which he discussed the various significant possibilities and the importance starting the academic field of Cognitive Science in Nepal (Pathak 2019).How the insights from the field of cognitive science can inform the teaching and learning process and how the schools can incorporate the findings of the researches coming out of this field has also raised curiosity among school teachers and managers. On May 25, 2019 Kathmandu University High School had organized Joint School Teachers' Workshop,for sixprominent schools from Kathmandu which was attended by 500 teachers, at St. Xavier's School, Jawalakhel, Lalitpur, Nepal. This researcher was invited for the opening Plenary Session for this workshop in which he spoke on the theme of "Science of Learning: Approaches from

Cognitive Science" (Pathak 2019). In recognition of the work done in the field of cognitive science by this researcher in Nepal, he was invited to deliver a Keynote Speech in the 3rd International Workshop of Society for Cognitive Science of Culture organized at Birla Institute of Technology and Science (BITS) University, Pillani Campus, in Goa, on February 3 - 7, 2020 in which he delivered his Keynote Speech on "Situation of Illiterates in Nepal: What does it mean for Cognitive Science?" (Pathak, 2020). This trip was also supported by the University Grants Commission (UGC), Nepal. In this workshop, a poster was also presented by Sabita Rijal and Lekhnath Sharma Pathak on "Bilingual Literacy Effect on Executive Control" based on an ongoing research work in the Cognitive Science and Psycholinguistics Lab (Rijal & Pathak 2020). It was the first work on Cognitive Science from Nepal which has been published from the Cognitive Science and Psycholinguistics Lab (Pathak & Pathak 2022, Pathak & Rijal 2022, Pathak 2022, Pathak *et al.* 2021).

The first master's thesis that came out of the Cognitive Science and Psycholinguistics Lab in the Central Department of Linguistics was by Sabita Rijal titled "Effect of first and second language mediated instruction on cognitive control: A psycholinguistic study" (Rijal 2020) under the supervision of Faculty-in-Charge and Principal Investigator of this lab, Lekhnath Sharma Pathak. This is also the first MA thesis in psycholinguistics and cognitive science in Nepal. This study measured and compared the linguistic and cognitive effects of medium of instruction in two government schools in Kathmandu district with similar kind of school management system that used either Nepali (first language) or English (second language) as medium of instruction. The study measured the differences in cognitive control tasks, language production and language comprehension tasks as modulated by the medium of instruction. A lexical decision task in L2 (English), LexTale (Lemhofer & Broersma 2012) was used to measure language comprehension in L2, a bilingual verbal fluency task (Golan & Montoya 2002) was used to measure language production in both the languages. Stroop task (Stroop 1935) and Flanker task (Poarch & van Hell 2012) were used in a mouse tracking paradigm to measure cognitive control. The study results showed an advantage of L2 instruction in which the children who were instructed in L2 performed much better than the children instructed through L1 in all the linguistic and cognitive measures. So much so that the children who were taught through L2 performed better in L1 production tasks as well compared to the children who were taught through L1. Besides these studies, psycholinguistic approach has been used in the teaching of language in an innovative manner (Pathak 2019) and investigating the typological phenomena like honorification in Nepali from psycholinguistic perspective (Pathak 2021).

Language is a cognitive phenomenon and psycholinguistics explains the way language it is represented and processed by our mind/brain. There is not enough body of research work that studies the languages of Nepal from psycholinguistic and cognitive perspective, except for the works done in the Central Department of Linguistics. This is the first study investigating the trilingual psycholinguistic processing in this language combination. This research is an attempt to fulfil the gap that exists in Nepalese linguistics in the area of mental lexicon in terms of language representation and language processing, especially among multilingual population.

This is the first study of its kind in Nepali academia in terms of research area and methodology. It is believed that this research will initiate interest in the scientifically valid experimental research in the field of humanities and social sciences especially in the areas of linguistics and psychology.

METHODS AND MATERIALS

BLINCS (Bilingual Language Interaction Network for Comprehension of Speech) (Shook & Marian 2013) Model that better explains our work as it accounts for audio-visual integration during comprehension of speech in bilinguals. In this model, activation begins simultaneously at the stages of phonological processing and semantic access as the visually presented objects and phonological inputs are given. Activation of the items in the visual display is increased with the phonological input entering the system and feeding upward to the phono-lexical level and feedback from semantic level down to the same phono-lexical level. For example, while presenting the English word *pear* with the image of a pear activates both English *pear* and Spanish *perro* "dog" but not *volcano* but if the image of the dog is presented then there is greater activation of *perro* than when only phonologically related word *pear* is given. Thus, visually presented objects activate lexical items in both the languages additionally activating semantic representation that feeds back to the phono-lexical items of both the languages. So, in our experimental design, the visually presented non-selective object sharing phonological similarity with the auditory input would activate it and attract the mouse trajectory toward itself before curving towards the target.

Inspired by bilingual studies, trilingual phenomena has influenced researchers to explore the cognitive implications of trilingualism. Different effects of multilingualism are starting to become visible (Hirosh & Degani 2017). Schroeder and Marian (2016) proposed a cognitive plasticity framework to account for cognitive differences and similarities between trilinguals and bilinguals. Using an event related potential (ERP) study, Kwon and Lee (2017) showed that learning third language brings changes in executive functions. Mulik, Carrasco-Ortiz & Amengual (2018) showed that bilinguals can activate lexical knowledge from both of their languages during novel L3 word learning, but the activation of the less-dominant L2 depends on participants' L2 proficiency.

Considering the existing models, the model that can inform and explain the current study is BLINCS (Bilingual Language Interaction Network for Comprehension of Speech) Model (Shook & Marian 2013) and has been adopted to explain the findings of this study.

Mouse-tracking is a novel paradigm that measures the continuous flow of dynamic cognitive processing and captures the graded flow of information from cognition to action (Spivey, Grosjean & Knoblich 2005, Freeman & Ambady 2010, Dale & Duran 2011) by tracking the hand movement as participants make responses. Several psycholinguistic studies have been conducted using mouse-tracking paradigm like spoken word recognition by tracking the temporal dynamics of lexical activation (Spivey *et al.* 2005), sexual orientation based on voice categorization of speakers (Sulpizio *et al.* 2015), parallel activation of syntactic representation (Farmer *et al.* 2007), cross-linguistic sentence processing (syntactic transfer) in bilinguals (Morett & Macwhinney 2012), bilingual advantage in executive control (Incera & McLennan 2015), medium of instruction effect in linguistic and cognitive processing (Pathak *et al.* 2021). It is an efficient tool in understanding the dynamics of human cognitive processing system (Pathak 2017). Trilingual parallel activation may be investigated using more advanced and sophisticated tools like eye-tracking or Event Related Potentials (ERP) using Electroencephalogram (EEG) but such tools are expensive and not available in Nepal and mouse-tracking is the most advanced tool available at no cost so far in conducting such research.

Participants for the study were adult people who are proficient in Nepali, English and Sanskrit in varying degrees of proficiency. Participants have been recruited on the basis of purposive random sampling.

The sample size of the population for this study was 24 participants (8 participants each with dominance in each language group). Table 1 provides a brief demographic information.

Table 1: Demographic information

Factor	Count
Mean age (SD)	38.08 (16.15)
Age range	18 - 67
Male	16
Female	8

The main source of data for this study was the experimental data collected from the participants. The dependent measures are the mouse-movement trajectories produced as a function of the experimental manipulation.

Following stimuli set was created for data collection. The spoken input was the word for target picture and an experimental manipulation was done creating phonological competitor and distractor condition.

In experimental condition, all together 96 trials were created by manipulating different conditions. Type wise, there were two types of trials: Phonological cohort and distractor. In phonological cohort, the picture opposite to the target picture activated word phonologically similar to the target picture and in distractor condition, the picture opposite to the target activated word which was phonologically dissimilar to the target word. Input wise, there were three conditions. The participants heard the spoken word in Nepali, English and Sanskrit in a randomized manner. In direction language condition, the phonologically similar word would be activated in other two languages besides the input spoken language. For example, if the input language was L1 (Nepali), 8 trials would be phonologically similar to L2 (English) and 8 phonologically similar to L3 (Sanskrit) with 16 trials which had no phonological similarity. Thus, each input language had altogether 32 trials, so three input languages would make it 96. All the trials were randomized and counterbalanced for the position of the occurrence.

Baseline condition with a location word ‘here’ in all the three languages serve as training and practice trials and also provided a basis to measure the experimental conditions.

Audio clips for auditory stimuli were created with Audacity software. The picture stimuli and Sanskrit words were taken from Sanskrit Picture Dictionary*Samskrta Citra-Kosah* (O'Sullivan 2012) and from the internet. All the pictures were black-and-white line and sketch drawings and were made in the same PNG format and were of 200 x 200 pixels for uniformity. The experiment was designed and run in a 15.6" HP Pavillion G Series laptop with 60 Htz refresh rate and display resolution of 1366 x 768 pixels. A wired optical mouse was used for making response on the computer screen. A high quality audio headphone with noise cancellation feature to avoid any external auditory noise and distraction was used for listening to the audio stimuli.

Informed Consent Form and Language Background Questionnaire was created for every participant to take their formal written consent for participation and to collect information about their language experience. A sample list of stimuli used in phonological competitor condition is given in Table 2 and a sample trial is given in Figure 1

Table 2: Stimuli used for phonological competitor condition

S. N.	Spoken word input	Left response	Right response
Sanskrit Input (L3 Sanskrit – L1 Nepali)			
१	अश्वः	अश्वः	अमला
२	गजः	गोभी	गजः
३	हंसः	हंसः	हात
४	कुक्कुरः	करेला	कुक्कुरः
५	मत्स्यः	मत्स्यः	मुख
६	मयुरः	माला	मयुरः
७	मेषः	मेषः	मेवा
८	मुसकिः	मादल	मुसकिः
Sanskrit input (L3 Sanskrit – L2 English)			
९	नक्रः	नक्रः	**Necklace**
१०	पपिलिकि	**Pen**	पपिलिकि
११	सूर्यः	सूर्यः	**Spoon**
१२	सहिः	**Cistern**	सहिः
१३	शृगालः	शृगालः	**Shoe**
१४	जीह्वा	**Jackfruit**	जीह्वा
१५	ललाटम्	ललाटम्	**Lemon**
१६	कङ्कणम्	**Kite**	कङ्कणम्

Figure 1: L1 – L2 Phonological competitor condition response screen (L1 पहाड– L2 Parrot)

RESULTS AND DISCUSSION

Initiation time

A 3x2x2 repeated measures ANOVA was performed with Input Language (First Language (Nepali), Second Language (English), Third Language (Sanskrit) x Direction Language (L1 to L2 or L3, L2 to L1 or L3, L3 to L1 or L2) x Type (Phonological competitor and Distractor).The main effect for input language was not significant $F1\ (2, 20) = 0.960$, $p > 0.05$, $\eta_p^2 = 0.088$. The main effect for direction language was not significant $F1\ (1, 21) = 2.749$, $p > 0.05$, $\eta_p^2 = 0.116$. The main effect for Type was not significant $F1\ (1, 22) = 0.799$, $p > 0.05$, $\eta_p^2 = 0.037$.

The main effect for input language x direction language was significant $F1\ (2, 20) = 3.622$, $p < 0.05$, $\eta_p^2 = 0.266$.

In this condition, the response latency is higher in distractor condition compared to the competitor condition which means when the participants heard the spoken word in L1 (Nepali) and direction of the word activated by the picture in the distractor condition was not matching phonologically with the target picture word, the participants took longer time to initiate the mouse in phonologically non-matching word compared to the phonologically matching word in L2 (English) direction.

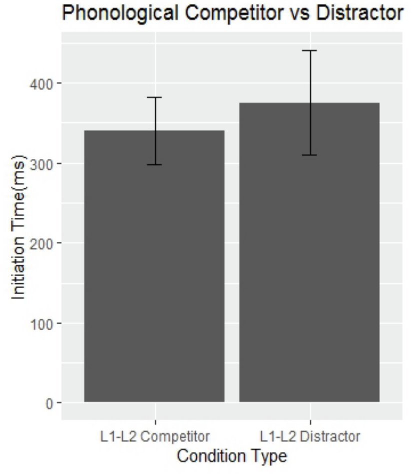

Figure 2: Initiation Time latency when Input was in L1 Direction Language was L2

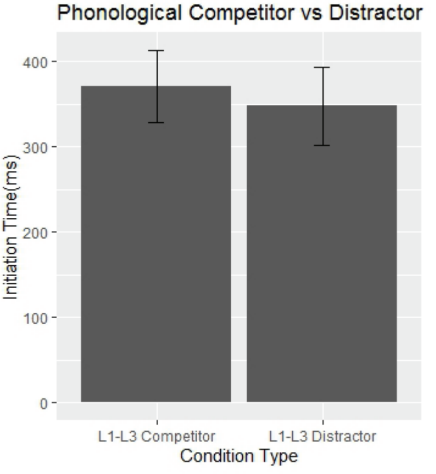

Figure 3: Initiation Time Latency when Input was in L1 Direction Language was L3

The initiation pattern is different in figure 2 which depicts the condition when the input language was L1 (Nepali) and the picture in the distractor condition opposite to the target picture activated the word in L3 (Sanskrit). In this condition, the latency is higher for the condition when the word activated by the picture in the distractor condition was phonologically similar to the target word, which means participants took longer time to initiate the mouse movement in phonologically matching condition.

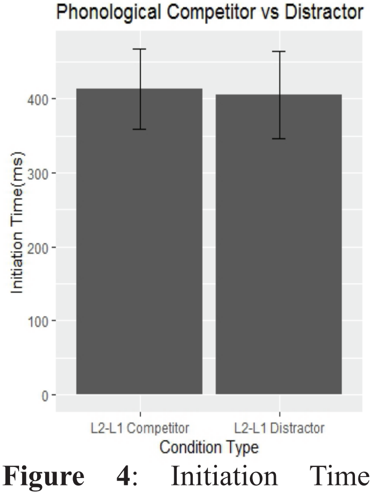

Figure 4: Initiation Time Latency when Input was in L2 Direction Language was L1

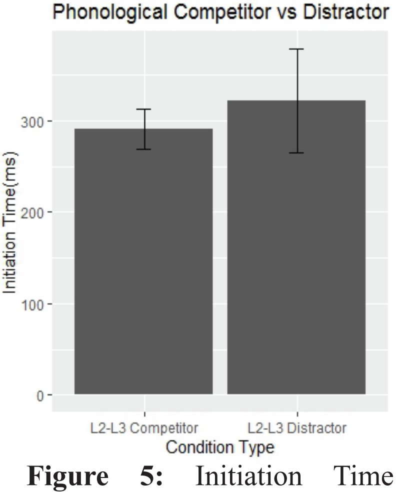

Figure 5: Initiation Time Latency when Input was in L2 Direction Language was L3

In the condition of figure 4, when the auditory input was in L2 (English) and the word activated by the picture in distractor condition opposite to target word was in the direction of L1 (Nepali). The initiation time latency was very marginally higher in phonological competitor condition but was not significant.

In the condition of figure 5, when the auditory input was in L2 (English) and the word activated by the picture in distractor condition opposite to target word was in the direction of L3 (Sanskrit). The initiation time latency was significantly higher in distractor condition which means participants took longer time in initiating the mouse movement in the condition when the activated word in distractor condition didn't match phonologically compared to the condition which had a phonological match.

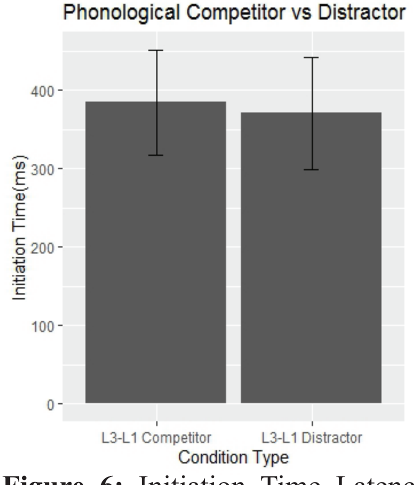

Figure 6: Initiation Time Latency when Input was in L3 Direction Language was L1

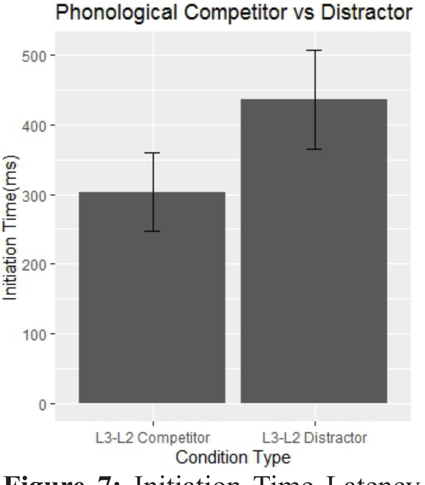

Figure 7: Initiation Time Latency when Input was in L3 Direction Language was L2

In the condition of figure 6, when the auditory input was in L3 (Sanskrit) and the word activated by the picture in distractor condition opposite to target word was in the direction of L1 (Nepali). The initiation time latency was very marginally higher in phonological competitor condition compared to phonologically non-matching condition but was not significant.

In the condition of figure 7, when the auditory input was in L3 (Sanskrit) and the word activated by the picture in distractor condition opposite to target word was in the direction of L2 (English). The initiation time latency was significantly higher in distractor condition which means participants took longer time in initiating the mouse movement in the condition when the activated word in distractor condition didn't match phonologically compared to the condition which had a phonological match.

Response time

A 3x2x2 repeated measures ANOVA was performed with Input Language (First Language (Nepali), Second Language (English), Third Language (Sanskrit) x Direction Language (L1 to L2 or L3, L2 to L1 or L3, L3 to L1 or L2) x Type (Phonological competitor and Distractor). The main effect for Type was significant F1 (1, 22) =16.135, $p< 0.05$, $\eta_p^2 = 0.423$.Pairwise comparison showed that when the response condition was phonologically matching, there was a significant ($p = 0.001$) difference compared to the condition that didn't have phonological match with the response latency being higher in phonologically non-matching distractor condition (Mean = 1989.656, SE = 83.520) compared to phonologically matching competitor condition (Mean = 1849.676, SE = 84.686) with a mean difference of 139.980 ms. (see to Figures 1 – 4)

There was no significant main effect for input language F1 (2, 21) =1.918, $p> 0.05$, $\eta_p^2 = 0.154$. Likewise, there was no significant main effect for direction language F1 (1, 22) =2.367, $p< 0.05$, $\eta_p^2 = 0.097$.

The main effect for input language and direction language interaction was significant F1 (2, 21) =7.461, $p< 0.05$, $\eta_p^2 = 0.415$. Pairwise comparison showed that when the input was in L2 (English) there was a significant ($p = 0.001$) difference between the direction language in L1 (Nepali) (Mean = 2069.735, SE = 110.027) and direction language in L3 (Sanskrit) (Mean = 1840.779, SE = 111.475) with a Mean Difference of 228.956 ms, SE = 60.836 ms.

The main effect for input language and type interaction was significant F1 (2, 21) =6.007, $p< 0.05$, $\eta_p^2 = 0.364$. Pairwise comparison showed that when the input was in L3 (Sanskrit) the response latency was significantly ($p = 0.001$) higher in distractor condition (Mean = 2105.407, SE = 65.303) compared to competitor condition (Mean = 1805.714, SE = 63.738) with a Mean Difference of 246.943 ms, SE = 62.665 ms.

The main effect for input language x direction language x type interaction was not significant F1 (2, 21) =1.707, $p> 0.05$, $\eta_p^2 = 0.140$.

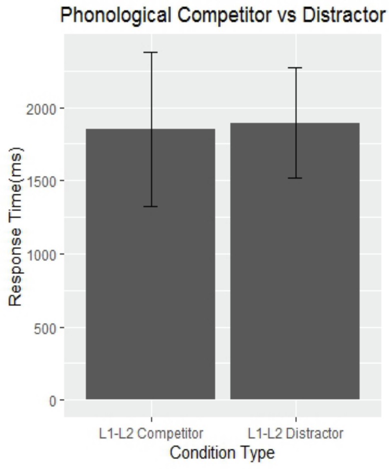

Figure 8: Phonological Competitor Versus Distractor when the Input Language was L1 and the Direction Language was L2

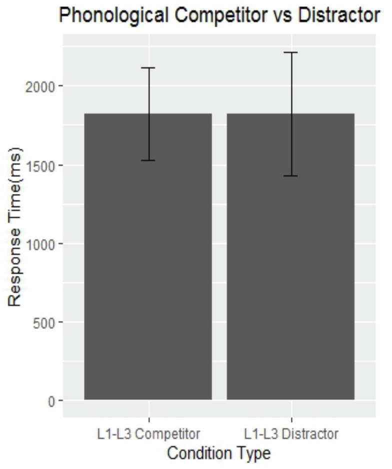

Figure 9: Phonological Competitor Versus Distractor when the Input Language was L1 and the Direction Language was L3

In figure 8, the response latency in distractor condition is higher than the response latency in phonological competitor condition. It shows the participants responded faster when the word activated by the target picture was phonological similar to the word activated by picture on the opposite side of the screen compared to when the word activated by the opposite/ distractor picture was phonologically dissimilar to the word activated by the target picture which was the right match to the auditory input. The auditory input in this condition was in L1 (Nepali) and the direction language was in L2 (English) in the distractor condition.

In figure 9, the response latency is not significantly different in both the conditions. The auditory input in this condition was in L1 (Nepali) and the direction language was in L3 (Sanskrit). The reason why there wasn't much difference in response latency in phonological matching and non-matching distractor is because Nepali and Sanskrit share many words which are cognate.

In figure 10, the response latency is significantly higher in distractor condition compared to phonological competitor condition as shown by the statistical analysis above. The auditory input in this condition was in L2 (English) and the direction language was L1 (Nepali). In this condition, the participants heard the spoken word in English and clicked the picture matching with the input spoken word. The distractor pictures on the opposite side of the target picture were either phonologically matching or non-matching in equal numbers. The participants processed the words activated by pictures with phonological similarity faster than the words activated by pictures phonologically non-matching.

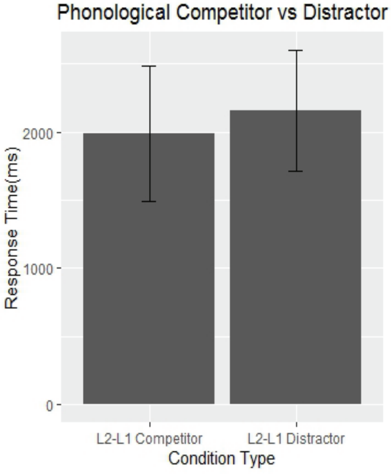

Figure 10: Phonological Competitor Versus Distractor when the Input Language was L2 and the Direction Language was L1

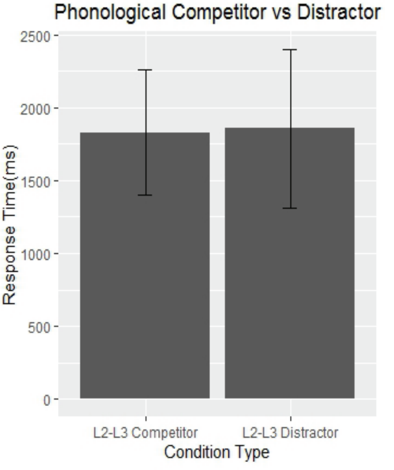

Figure 11: Phonological Competitor Versus Distractor when the Input Language was L2 and the Direction Language was L3

In figure 11 above, the response latency is marginally higher in distractor condition. In this condition, the input language was in L2 (English) and the direction language was L3 (Sanskrit). When the participants heard the spoken word in English, the pictures on the opposite side of the matching target picture would activate the word in Sanskrit of which half of them would have words matching phonologically with the input word and half of them would activate words which were not matching phonologically with the input spoken word.

In figure 12, the response latency is significantly higher in distractor condition compared to phonological competitor condition as shown by the statistical analysis above. The auditory input in this condition was in L3 (Sanskrit) and the direction language was L1 (Nepali). In this condition, the participants heard the spoken word in Sanskrit and clicked the picture matching with the input spoken word. The distractor pictures on the opposite side of the target picture were either phonologically matching or non-matching in equal numbers. The participants processed the words activated by pictures with phonological similarity faster than the words activated by pictures phonologically non-matching.

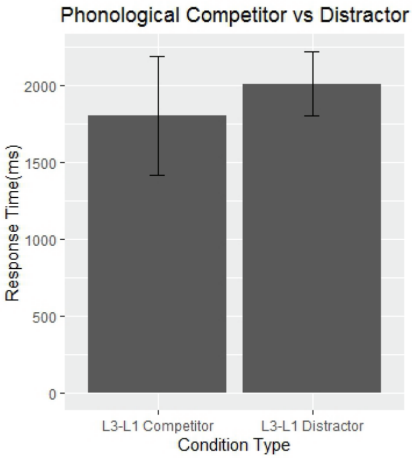

Figure 12: Phonological Competitor Versus Distractor when the Input Language was L3 and the Direction Language was L1

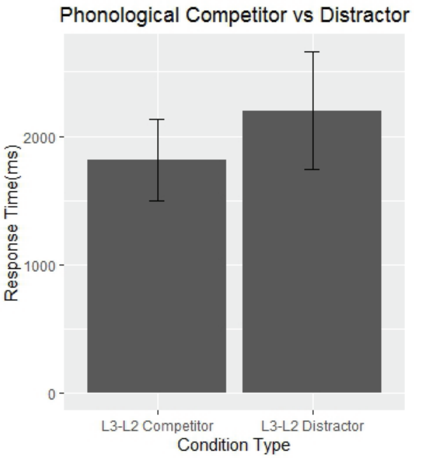

Figure13: Phonological Competitor Versus Distractor when the Input Language was L3 and the Direction Language was L2

In figure 13 above, the response latency is significantly higher in distractor condition. In this condition, the input language was in L3 (Sanskrit) and the direction language was L2 (English). When the participants heard the spoken word in Sanskrit, the pictures on the opposite side of the matching target picture would activate the word in English of which half of them would have words matching phonologically with the input word and half of them would activate words which were not matching phonologically with the input spoken word.

Statistical analysis showed significant difference in response time latency when the word activated by the picture opposite to target word was phonologically matching or not. The latency was higher in non-matching condition suggesting that the phonological similarity might have facilitated the response speed.

This study investigated the extent of parallel language activation when three languages (Nepali, English and Sanskrit) are processed simultaneously. The baseline condition was created to measure the temporal latency in the initiation and response time without experimental manipulation. If there was a difference in the initiation and response pattern in the experimental condition compared to the baseline condition, it would clearly establish that the experimental design had worked successfully and the experiment was able to capture and measure the parallel language activation through the experimental manipulation. The measurement showed that there was no significant difference in initiation time and response time in any of the three language response conditions. This gave a basis to compare the experimental condition. In the experiment, there was no significant difference in any of the experimental condition in the initiation of the mouse movement. This means the participants initiated the mouse movement in almost similar manner in all the three language conditions. The main result was quite clear in the response time measurement. The participants had to listen to a spoken word and click on the matching picture that appeared on the top left or right of the computer screen. The picture on the opposite side of the target picture was manipulated phonologically to test the parallel language activation. The picture in the distractor condition would activate word that was either phonologically similar to the target word or was phonologically dissimilar to the target word. There was a significant response latency difference between the phonologically similar and dissimilar condition. The participants were generally faster in the phonologically similar condition, compared to dissimilar condition. There was significant interaction between the manipulated conditions. The study established the parallel language activation in all the three languages through the response latencies.

CONCLUSIONS

Previous studies with bilingual have shown that when two words are activated simultaneously, the words matching phonologically take longer time before the target word is selected as a consequence of the competition felt from the initial phoneme for selection compared to when the distractor word is not a phonological cohort. Whereas in trilingual condition, we found even while initiating the mouse movement participants took shorter time in resolving the phonological competition as they were faster in initiating the mouse in phonologically matching condition compared to in non-matching condition. But this pattern of activation differed in the situation when both the languages were relatively more dominant compared to when one of the languages was more dominant than the other. That language dominance influences parallel activation in bilingualism and trilingualism differently is an issue that needs further investigation in future studies.

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